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Yield Components in Oats. IV. Effect of Delayed Application of Nitrogen

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Yield Components in Oats. IV. Effect of Delayed Application of Nitrogen[1]

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Abstract. Three rates of nitrogen fertilization, 20, 40, and 80 pounds per acre, were applied to oats at seeding time and 2, 4, and 6 weeks later. When compared with the seeding data, delaying the application of 20 and 80 pounds of nitrogen caused a decrease in relative grain yields. At the 40-pound rate, increases in relative yields due to applying the nitrogen 2 and 4 weeks after seeding were observed. The yield response to delayed application of 20 pounds of nitrogen per acre resulted from a reduced relative number of seeds per head, while the 80 pound response was due both to reduced relative seed size and number of seeds per head. The increase in relative grain yield from 40 pounds of nitrogen applied 2 to 4 weeks after seeding was caused by an increased relative number of heads per plant and seeds per head.

Delaying the application of nitrogen fertilizer after planting of field crops has received considerable investigation. Davidson and LeClerc (1917) found that sodium nitrate would increase wheat yields only if applied before the seedlings were 2 inches high. Later, Davidson (1922) reported progressively decreasing effect on yield as the nitrogen application was delayed. Gericke (1922), working with oats, and Watson (1936), working with wheat, found that grain yields were approximately constant when nitrogen was applied any time between seeding and booting, whereas when applied after heading it was ineffective in increasing yields. Brieba (1947) showed that 20 pounds of nitrogen applied to oats gave equal increases in grain yields irrespective of whether it was applied at seeding time or 1, 4, or 6 weeks later. However, when it was applied 8 weeks after seeding, the grain yield decreased sharply. Similar results were found with a 40-pound application, but with 80 pounds of nitrogen the decrease in grain yields was noted with the 6-week application.

These studies indicate that nitrogen fertilization of small grains can be delayed for a period after seeding without a decrease in the nitrogen effect on grain yield. The variance among studies relative to the latest application date which gave optimum yields probably resulted from the conditions peculiar to the experiments. The present paper reports the effect of delayed nitrogen application not only upon grain yield, but also upon the three components of yield, i.e., number of heads per plant, number of seeds per head, and weight per seed.

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Materials and Methods

The oat varieties used in this study were C. I. 5298, Bond, Clintland, Gopher, Huron, Marion, Mo. 0-205, Park, Simcoe, and Victorgrain, grown at Ames, Iowa, in 1954. All the varieties except Park and Victorgrain were well adapted to Iowa. Since the varieties reacted similarly to the fertilization treatments the data were pooled.

Ammonium nitrate was broadcast on the plots at seeding time and 2, 4, and 6 weeks later at rates which gave the equivalent of 20, 40, and 80 pounds of nitrogen per acre. Prior to seeding, 300 pounds of 0-20-20 fertilizer was applied per acre to provide adequate phosphorus and potassium to permit full expression of response to nitrogen. The experimental design was a split plot replicated 3 times with factorial fertilization rate and date combinations occupying the whole plots and varieties the subplots. A subplot consisted of 1 row 8 feet long with a 1-foot spacing between rows, and the seeding rate was 3 bushels per acre.

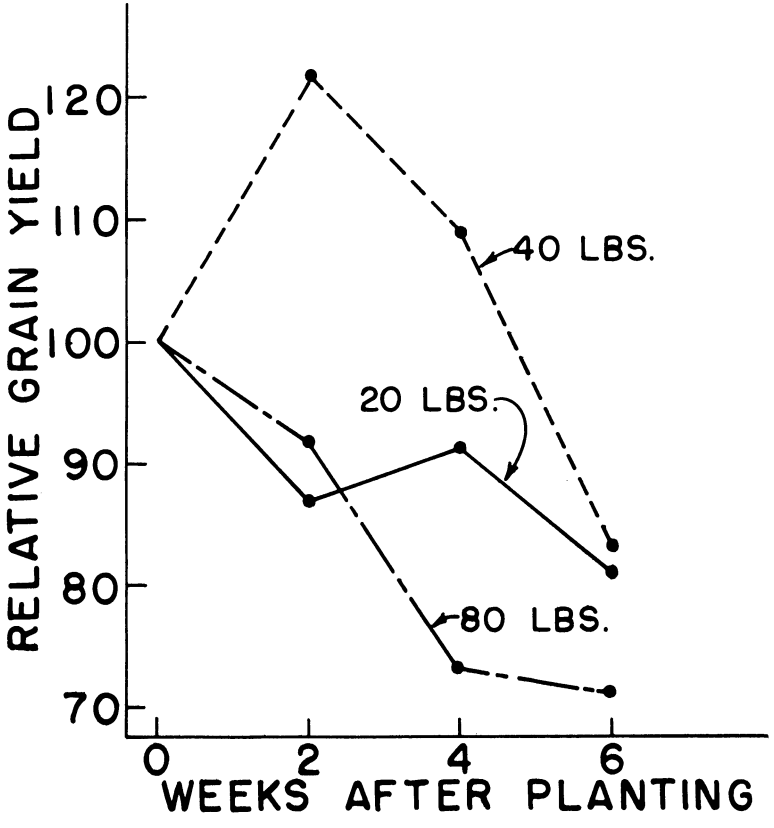

Figure 1. Relative grain yields of oats fertilized with 20, 40, and 80 pounds of nitrogen per acre at seeding time, and 2, 4, and 6 weeks later.

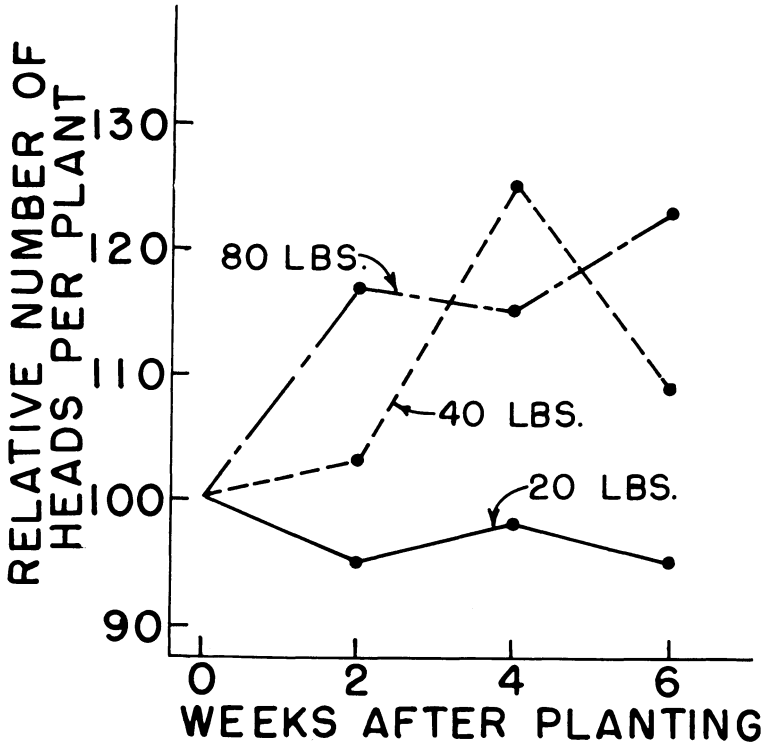

Figure 2. Relative number of heads per plant of oats fertilized with 20, 40, and 80 pounds of nitrogen per acre at seeding time and 2, 4, and 6 weeks later.

The seedlings and panicles were counted in a 2-foot section of each plot 2 weeks after sowing and at maturity, respectively. The 2-foot sections were selected at random and marked with 4-inch pot labels so that seedling and head counts could be made on the same areas. At maturity each section was harvested, threshed, weighed, and the weights of duplicate 100-seed samples determined. From these data average numbers of heads per plant and seeds per head were computed.

The oat plants were protected from foliar diseases with Parzate sprayed on at weekly intervals from heading time until maturity. No lodging occurred in this experiment in spite of the high rates of nitrogen fertilization.

Experimental Results

The means for grain yield and each component are presented on a relative basis, with the seeding date application of a given nitrogen rate as 100 percent. The mean response to a nitrogen rate and date of application combination was obtained by averaging the data for

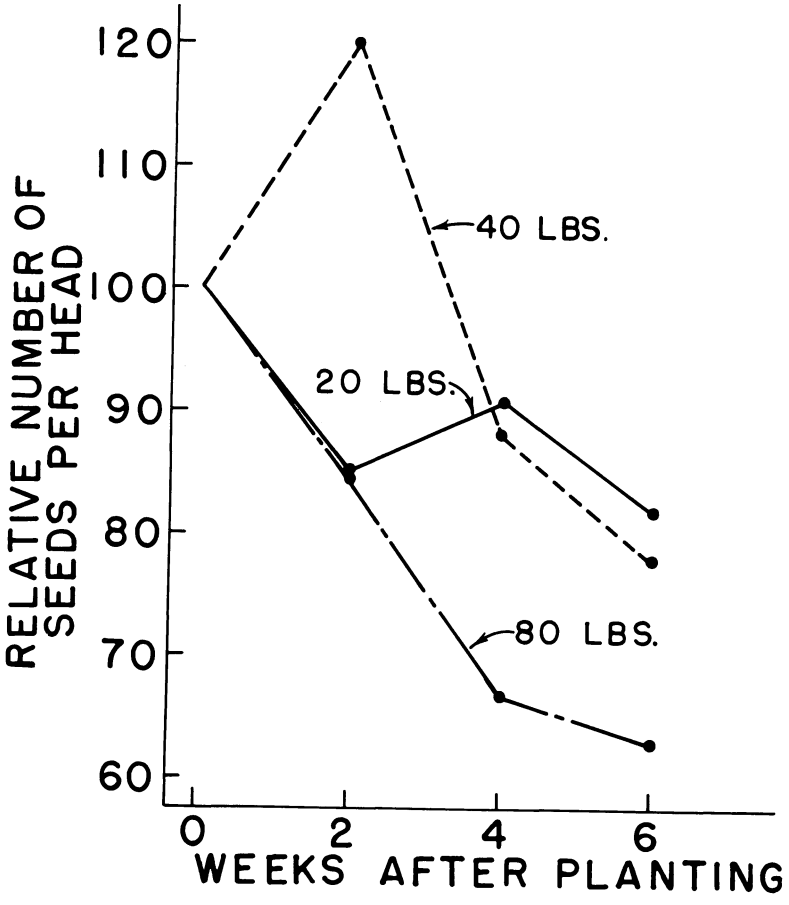

Figure 3. Relative number of seeds per head of oats fertilized with 20, 40, and 80 pounds of nitrogen per acre at seeding time and 2, 4, and 6 weeks later.

all varieties in establishing the relative grain yield and its components; thus each point plotted in figures 1 to 4 represents the mean of 30 estimates.

The relative oat grain yields for the 20-, 40-, and 80-pound rates of nitrogen fertilization applied at seeding time and 2, 4, and 6 weeks later are presented in Figure 1. Delayed application of nitrogen caused a marked grain yield increase above the sowing time application only at the 40-pound rate.

The yield component mechanism responsible for the differential grain yield reaction of the 40-pound rate and the 20- and 80-pound rates, at different dates of application, is illustrated in Fig-

ures 2, 3, and 4, which give the relative number of heads per plant, number of seeds per head, and weight per seed, respectively.

At the 20-pound rate of nitrogen application, little effect on either the number of heads per plant or seed weight resulted from delaying the application 2 to 6 weeks after seeding. However, the number of seeds per head was reduced 10 to 15 percent by delayed application. Since the slight decrease in number of heads per plant and increase in seed weight approximately compensated for one another, the reduction in relative grain yield corresponded closely to that for relative number of seeds per head.

Seed weight was not affected by the application of 40 pounds of nitrogen 2, 4, and 6 weeks after seeding in comparison with application of nitrogen at seeding time, but the number of heads per plant was increased 3 to 25 percent. The number of seeds per head was 20 percent greater with the 2-week application, but the 4- and 6-week applications resulted in a reduced number of seeds per head. As a result of the combination of increased production of heads per plant and seeds per head, the 40-pound application of nitrogen

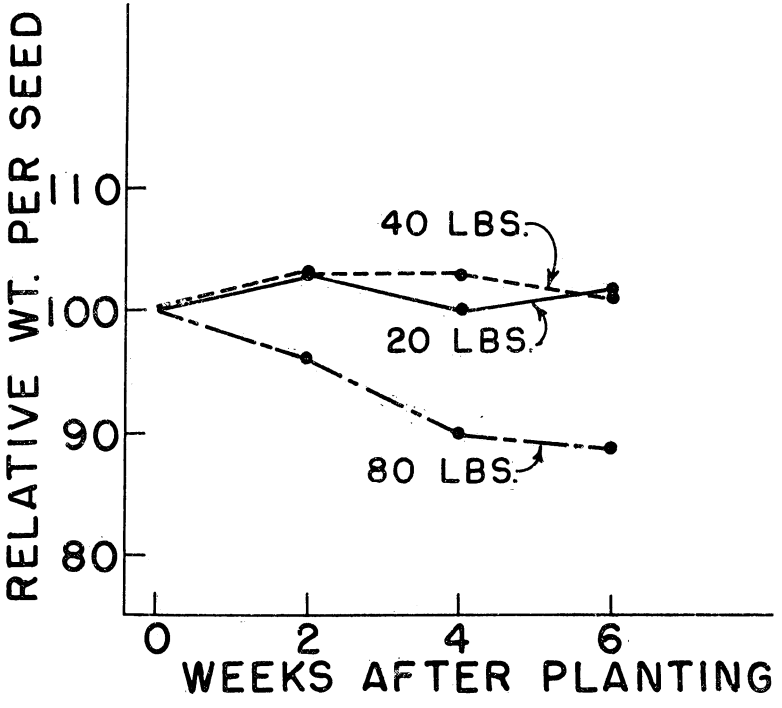

Figure 4. Relative weight per seed of oats fertilized with 20, 40, and 80 pounds of nitrogen per acre at seeding time and 2, 4, and 6 weeks later.

caused an increase in relative grain yield when applied either 2 or 4 weeks after sowing.

The delayed application of 80 pounds of nitrogen for 2 to 6 weeks after seeding caused an 18 to 25 percent increase in heads per plant, but a reduction of 5 to 10 percent in seed weight and 15 to 35 percent in number of seeds per head. The net effect was reduced relative grain yield for all delayed applications of 80 pounds of nitrogen per acre, because the last two characteristics overshadowed the first one.

The interaction responses to rate and date of nitrogen fertilization for each yield component are intriguing. For example, why did 40 and 80 pounds of nitrogen per acre cause an increased number of heads per plant when application was delayed, while 20 pounds did not? Perhaps 20 pounds of nitrogen was adequate only to supply the needs for the culms already growing, whereas the 40- and 80-pound applications furnished an excess which was used to initiate tiller growth. Delayed application of 80 pounds of nitrogen per acre caused a reduction in relative seed weight, but 20 and 40 pounds did not. The 80-pound rate may have increased the vegetative growth to the extent that it competed with the grain filling process for moisture and nutrient supply, while for the lower nitrogen rates vegetative growth was not competitive during this period. Unfortunately, grain-straw ratios were not measured.

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